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Benthic Foraminiferal Morphogroups from the Paleogene of the Republic of Macedonia – preliminary data

Бентосни фораминиферни морфогрупи от Палеогенската система в Република Македония – предварителни данни

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The Paleogene sediments of the Republic of Macedonia contain diverse benthic foraminiferal microfauna (geological sketch-map with the distribution of the Paleogene sedimentary basins and the locations of the studied sections containing foraminifers were recently published by Stojanova et al., 2013). A total of 65 species have been recorded and described previously (Džuranov et al., 1999; Valchev et al., 2013a, b). This high taxonomic diversity led us to do the first step for estimating the paleoecological significance of the foraminiferal assemblages – a definition of groups of tests based on characteristic features of their morphology. On the basis of test shape (*i*) and the nature of test coiling (i.e. chamber addition) (*ii*), we defined and illustrated 11 morphological groups (morphogroups or morphotypes) (see Fig. 1).

1) Rounded trochospiral morphogroup (RT). It includes species with trochospiral mode of coiling and broadly rounded periphery (Fig. 1, 1–2): *Baggina subconica* (Terquem), *Valvulineria jacksonensis* Cushman, *Anomalinoides acutus* (Plummer), *A. danicus* (Brotzen), and *A. welleri* (Plummer).

2) Plano-convex trochospiral morphogroup (PT). It is represented by examples with trochospiral tests, having flat spiral side and narrowly rounded to sharp periphery (Fig. 1, 3–4): *Cibicides carinatus* (Terquem), *C. lobatulus* (Walker and Jakobs), *C. tallahatensis* Bandy, *C. ungerianus* (d’Orbigny), *C. cf. westi* Howe, *Cibicides* sp., *Gyroidinoides soldanii* (d’Orbigny), *Pararotalia audouini* (d’Orbigny), and *P. subinermis* Bhatia.

3) Biconvex trochospiral morphogroup (BT). It contains species with trochospiral mode of coiling and biconvex morphology, characterized by sharply angled to narrowly rounded periphery (Fig. 1, 5–6): *Trochammina deformis* Grzybowski, *Eponides minima* Cushman, *Eponides* sp., *Cibicidoides* sp., *Heterolepa dutemplei* (d’Orbigny), and *H. perlucida* (Nuttall).

4) Milioline morphogroup (M). It consists of species with flattened tests, elliptical outline and milioline chamber arrangement (Fig. 1, 7): *Spiroloculina communis communis* Cushman et Todd, *Quinqueloculina juleana* d’Orbigny, *Quinqueloculina* sp., *Triloculina angularis* d’Orbigny, *T. gibba* d’Orbigny, *Hauerina* sp., and *Pyrgo bulloides* (d’Orbigny).

5) Rounded planispiral morphogroup (RP). It includes compact tests with planispirally arranged chambers and broadly rounded periphery (Fig. 1, 8): *Nonion graniferum* (Terquem), *Nonionella winniana* Howe, *Mellonis affine* (Reuss), and *Pullenia quinqueloba* (Reuss).

6) Lenticular morphogroup (L). Species from this group display biconvex morphology with sharply angled or keeled periphery (Fig. 1, 9): *Lenticulina* cf. *wilcoxensis* (Cushman, Ponton), *Lenticulina yaguatensis* (Bermudez), and *Lenticulina* sp.

7) Tapered and cylindrical morphogroup (T/C). It is represented by forms with round, oval or triangular cross section, and parallel or subparallel sides (Fig. 1, 10). Rectilinear and straight uniserial, biserial and triserial tests are included in this morphogroup: *Marssonella indentanta* (Cushman et Jarvis), *Textularia bronniana* (d’Orbigny), *Textularia minuta* Terquem, *Nodosaria ewaldi* Reuss, *Nodosaria* sp., *Glandulina ovula* d’Orbigny, *Bulimina sculptilis* Cushman, *B. trigona* Terquem, *Fursenkoina dibollensis* (Cushman et Applin), *Caucasina eoacena* Chalilov, *C. tenebricosa* Pishvanova, *Siphonodosaria adolphina* (d’Orbigny), and *Chilostomelloides balkhanensis* (Dain and Chalilov).

8) Spherical morphogroup (S). It contains species of unilocular and inflated planispiral or trochospiral multilocular tests (Fig. 1, 11): *Saccammina placenta* (Grzybowski), *Lagena humifera* Bandy, *Lagena striata* (d’Orbigny), *Globulina gibba* d’Orbigny, *Guttulina*

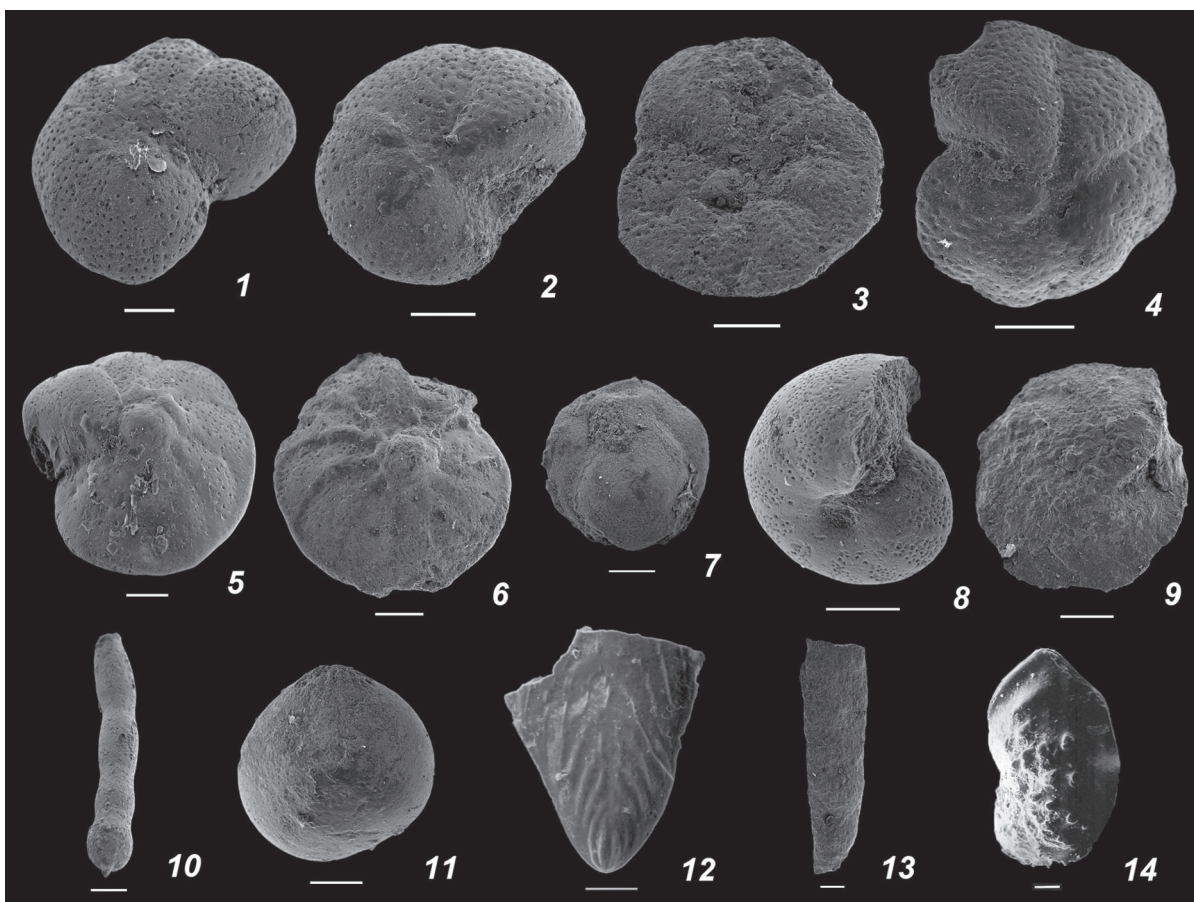


Fig. 1. Examples of benthic foraminiferal morphogroups, defined in this study

1–2, RT morphogroup: *Anomalinoidea welleri* (Plummer), section Krivolak, upper flysch unit, sample 3: 1, spiral view (SEM x 190) and 2, umbilical view (SEM x 150); 3–4, PT morphogroup: *Cibicides lobatulus* (Walker and Jakobs), section Hadzi Jusufli, upper flysch unit, sample 7: 3, spiral view (SEM x 180) and 4, umbilical view (SEM x 160); 5–6, BT morphogroup: *Heterolepa perlucida* (Nuttall), section Rabrovo, upper flysch unit, sample 15: 5, umbilical view (SEM x 150) and 6, spiral view (SEM x 180); 7, M morphogroup: *Pyrgo bulloides* (d'Orbigny), section Hadzi Jusufli, upper flysch unit, sample 3 (SEM x 180); 8, RP morphogroup: *Mellonis affine* (Reuss), section Rabrovo, upper flysch unit, sample 15 (spiral view, SEM x 230); 9, L morphogroup: *Lenticulina* sp., section Krivolak, upper flysch unit, sample 2 (SEM x 180); 10, T/C morphogroup: *Nodosaria ewaldi* Reuss, section Dedeli, upper flysch unit, sample 6 (SEM x 65); 11, S morphogroup: *Globulina gibba* d'Orbigny, section Krivolak, upper flysch unit, sample 7 (SEM x 170); 12, FT morphogroup: *Palmula budensis* (Hantken), section Nemanjici, upper flysch unit, sample 5 (SEM x 180); 13, T morphogroup: *Bathysiphon* sp., section Krivolak, sample 1 (SEM x 110); 14, H morphogroup: *Percultazonaria fragaria* (Gümbel), section Nemanjici, upper flysch unit, sample 10 (SEM x 110). Scale bar = 100 µm.

irregularis (d'Orbigny), and *Favulina hexagona* (Williamson).

9) Flattened tapered morphogroup (FT). This group includes uniserial, biserial and palmate tests, with ovate to compressed in cross section, and parallel to subparallel sides (Fig. 1, 12). It is represented by *Spiroplectinella carinata* (d'Orbigny), *S. dentata* (Alth), *Palmula budensis* (Hantken), *Bolivina* cf. *antegressa* Subbotina, *B. cf. cookei* Cushman, *B. gracilis* Cushman and Applin, *B. nobilis* Hantken, *B. reticulata* Hantken, and *B. scalprata* Schwager.

10) Tube-shaped morphogroup (T). This group combines examples with simple morphology – straight or curved single tubes having flattened or rounded cross section (Fig. 1, 13), and agglutinated wall (e.g. *Bathysiphon* sp., and *Hyperammina* sp.).

11) Heteromorphous morphogroup (H). It includes forms showing two or more types of chamber

arrangement (Fig. 1, 14): *Percultazonaria fragaria* (Gümbel).

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